NASA TECH BRIEF

Multibody Interplanetary Swingby Trajectories (MIST-1)

The problem:

To provide a computer operated procedure for determining interplanetary trajectories which use the gravitational perturbation of an intermediate planet to shape the trajectory.

The solution:

MIST-1 is designed to allow a mission analyst to investigate the advantages and disadvantages associated with two mission types and to determine the characteristics of multiplanet swingbys.

How it's done:

When a vehicle approaches a planet on a free fall trajectory, the gravitational influence of that body can radically alter the vehicle's trajectory about the sun. Advantage may be taken of this perturbation to plac the probe on a trajectory which will intercept another planet. Some planetary configurations when allied with certain trajectories will even yield multiplanet flybys. The new isolation procedure incorporated in this program will rapidly determine those trajectories which utilize a maximum of three flybys. The program will also compute single planet flybys and direct transfer trajectories.

Most isolation techniques proceed sequentially along the trajectory path; i.e., a trajectory is run from planet A to planet B. With that portion of the total trajectory fixed, an attempt is made to find a trajectory which will link planet B to planet C and allow a zero V linkage with the A to B leg. This is very time consuming and also leads to variable total trip time. The procedure described in this program is very rapid since it requires a minimum of trial trajectories to be generated and also allows the total trip time to be input as a fixed quantity.

The three principle systems employed in MIST-1 use as their fundamental plane the mean ecliptic, the mean plane of the earth's orbit around the sun. Their principle axis is established by the ascending node of the mean ecliptic on the mean celestial equator, a plane coplanar with the earth's mean equator. This ascending node is usually referred to as the vernal equinox for it marks the point at which the mean sun appears to cross the mean equator from south to north.

In all modes of operation, the program first determines the heliocentric conic which connects the centers of two planets and which requires a given trip time. With a known planetary ephemerides, this calculation is completely equivalent to the classical orbit determination problem in which a time and two position vectors are given. From the several techniques available, an extension of Lambert's theorem was chosen for use in MIST-1. The theorem expresses the trip time as a function of the magnitudes of the position vectors, the magnitude of the chord separating the end points of those vectors, and the semimajor axis of the transfer conic.

Notes:

1. This program is written in FORTRAN H for use on the IBM 360 computer.

2. Inquiries should be made to:
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